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Transportation Management Center Staffing and Scheduling for Day-to-Day Operations

Final Tool Evaluation Report

March 2006

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16. Abstract The TMC Staffing and Scheduling Tool is a simple software tool designed to assist TMC managers in making scheduling decisions. The Tool Evaluation Report summarizes the activities and results of usability testing of the TMC Staffing and Scheduling Tool.				
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1 Introduction

1.1 Identification

The research presented in this document was performed by the Georgia Tech Research Institute (GTRI) under the sponsorship of the Federal Highway Administration (Contract No. DTFH61-01-C-00049). The contract officer's task order manager (COTM) is Raj Ghaman. The GTRI project director for this contract is Dr. Dennis J. Folds. The work was performed by researchers in GTRI's Electronic Systems Laboratory (ELSYS).

1.2 Purpose

The effective and efficient operation of transportation management centers (TMCs) depends on numerous factors including the utilization of human resources. The development of staff planning and scheduling systems to support the day-to-day operations of TMCs has been limited. The primary objective of the contract is to provide a Technical Document for managers, supervisors, human resources personnel, and private contractors who are responsible for TMC staffing and scheduling that addresses the concepts, methods, processes, tasks, techniques, and other issues related to work analysis, scheduling, and staff planning. The second objective is to create an easy-to-use tool that will assist TMC managers in making staff planning and scheduling decisions. The third objective is to define the functional requirements for an interactive software tool, to be developed in a subsequent initiative, that will fully support TMC managers in making staffing and scheduling decisions.

The present document summarizes the results of the evaluation performed on the TMC Staffing and Scheduling Tool, and presents recommendations that are expected to improve the adequacy and ease-of-use of the tool.

The following statements in the Statement of Work are applicable to the Tool Evaluation Report:

> *"The draft evaluation report shall contain a summary of the evaluation results and recommendations for improvements and revisions to the tool. The evaluation report is intended to provide feedback on the tool produced by this project. The report will be used to (1) judge the adequacy of the tool, (2) suggest further development, and (3) provide an initial case study that may be used in promoting the dissemination of the products."*

1.3 Definitions

The primary standard driving the evaluation of the user interface and interaction of the TMC Staffing and Scheduling Tool is ISO 9241, entitled *Ergonomic requirements for office work with visual display terminals*. ISO 9241 part 11 provides guidance on usability, and this evaluation report adopts the following definitions with respect to usability of the tool's user interface:

Usability   *The extent to which a product can be used by specified users to achieve specified goals with **effectiveness**, **efficiency** and **satisfaction** in a specified context of use.*

Effectiveness   *The accuracy and completeness with which specified users can achieve specified goals in a particular environment.*

Efficiency   *The resources expended in relation to the accuracy and completeness of goals achieved.*

Satisfaction   *The comfort and acceptability of the work of the system to its users and other people affected by its use.*

2   Tool Evaluation Report

This document briefly describes the methods used to perform an evaluation of the TMC Staffing and Scheduling Tool, and details the results of usability testing for the tool. The primary purpose of the evaluation was to assess users' ability to use each of the tool's functions, and users' ability to produce and understand the tool's outputs. The evaluation used a combination of two formative approaches to usability testing: (1) an expert inspection and heuristic evaluation of the software functionality and user interface conducted by a human factors engineer possessing the skills required to perform usability analyses, and (2) user-in-the-loop testing conducted after initial software development of the tool was complete. The usability test approaches were tailored to the specifics of the software design, with regard to the scope and functionality of the tool.

2.1   Description

The TMC Staffing and Scheduling Tool is a simple software tool designed to assist TMC managers in making scheduling decisions. The tool allows users to define any number of shifts with any number of work hours in a 24 hour period, and allows users to input the demand (in terms of the number of operators required) for each hour of the day for each day of the week. Once the demand information is entered by the user, the tool calculates the number of employees needed for each shift on each day of the week, and the day on which each employee starts his or her work week (assuming a 5 on/2 off work week). The tool also calculates two other values, "scheduling efficiency" and "excess hours per week," that are measures of the efficiency of the calculated schedule. With a few additional inputs, the tool can also calculate the "relief factor" for the TMC, which accounts for the average number of days off employees receive and increases the required number of employees accordingly.

2.2   Test Objectives

Two test objectives were identified to fully evaluate the usability of the user interface of the TMC Staffing and Scheduling Tool.

Objective 1

The first test objective was to identify potential usability problems with the tool's functionality and output content with sufficient time to conduct iterative modifications of the tool (if required) prior to software delivery. The areas to be evaluated included the *effectiveness* and *efficiency* of the input and output components of the tool's user interface. This objective was accomplished via expert inspection and heuristic evaluation of the tool using widely known and accepted usability principles. The expert evaluation was performed by a human factors engineer trained to conduct usability analyses.

Objective 2

The second test objective was to receive end-user feedback from a domain expert regarding the usability and usefulness of the TMC Staffing and Scheduling Tool. The user, a TMC manager, followed pre-defined scenarios to complete the evaluation. Areas evaluated included the ease of use of the input components of the software tool, ease of

understanding and interpretation of the output components of the tool, the degree of *satisfaction* with the adequacy of the tool, and its value to practitioners. Upon completion of the evaluation scenarios, the user documented difficulties encountered, provided suggestions for design changes, and provided subjective ratings of evaluation items.

2.3   Methods and Measures

System performance measures were taken in conjunction with the evaluations. The areas to be assessed in Evaluation I included the *effectiveness* and *efficiency* of the input and output components of the tool's user interface. The areas to be assessed in Evaluation II included the ease of use of the input components of the software tool, ease of understanding and interpretation of the output components of the tool, and degree of *satisfaction* with the adequacy of the tool and its value to practitioners.

Evaluation I – Inspection by Human Factors Expert

Evaluation I used a usability inspection method known as heuristic evaluation. During the evaluation session the human factors expert interacted with the interface numerous times to inspect each interface component, and compared implementation of the interface components with a list of recognized usability principles. Of specific concern was the degree of achievable accuracy and completeness of the user interface input and output components (i.e., system *effectiveness*), as well as the relative level of effort required to obtain the desired degree of effectiveness (i.e., system *efficiency*). The evaluator also assessed the severity of each usability problem based on four factors: how common the problem is likely to be, how easy is it for the user to overcome, whether the problem is likely to be a one-off problem or one that persists, and how seriously the user will perceived the problem. These four factors were combined to provide rationale for overall severity rating scores that fall on a scale of 0 to 4:

0 – Not a usability problem	May be used to document positive aspects
1 – Cosmetic problem only	Need not be fixed unless extra time allows
2 – Minor usability issue	Fixing this should be given a low priority
3 – Major usability issue	Important to fix, and should be given higher priority
4 – Critical usability problem	Imperative to fix this before the product is released

Evaluation II – Inspection by Domain Expert

Evaluation II was an inspection by a domain expert, a TMC operations manager from the Atlanta TMC. The performance measure for the end-user portion of the usability testing is a rating for each item under evaluation. Ratings were made on a four point scale, with 1 being unsatisfactory and 4 being satisfactory. These judgments were made on the following basis:

1 – Unsatisfactory	Difficult to use or inadequate content
2 – Marginally Unsatisfactory	Usable, but an alternative implementation or explanation would be considerably better

3 – Marginally Satisfactory   Minor suggestions for improvement
4 – Satisfactory   Happy with functionality and content

Evaluations resulted in satisfactory/unsatisfactory judgments from the participant for each element of design under test. In addition, the user was asked to record additional information such as task duration, an assessment of tool usefulness, suggestions for design changes, and a log of difficulties experienced during the performance of the task (either due to the design of the tool or software bugs). The results data reflect the ease of use of the input components of the software tool, ease of understanding and interpretation of the output components of the tool, and degree of *satisfaction* with the adequacy of the tool and its value to practitioners

2.4 Results and Recommendations

Detailed descriptions of issues discovered, along with recommendations to consider, are presented in this section. A summary table of the issues, recommendations, and severity ratings for the salient input and output evaluation items is provided in at the end of this section in Table 6.

2.4.1 Using the interface to input data into the tool

The domain expert user provided the following ratings and comments related to inputting data into the tool:

Table 1: Data input overall ease of use user ratings and comments.

Evaluation Item	Satisfaction Rating	Comments
Overall Ease of Use		
Opening the application	4	
Designating work hours for a particular shift	3	Easy but adding actual clock times (24 hr clock) to the top row would make it easier to relate shift start and end times and make it easier for someone else trying to interpret another person's schedule development.
Adding shifts	4	
Removing shifts	4	
Saving an input data file	4	
Loading an input data file	4	
Time needed to complete all the data input that is required	3	Adding "Operators required by hour" could be simplified if a "hot key" could be designated to either (1) fill in the same number down the entire row or (2) in the next cell.

2.4.1.1 Opening the application

The task of opening the application is considered satisfactory by the domain expert (the user provided a satisfactory rating of 4 to indicate that he was happy with the feature or functionality). TMC managers who are responsible for the staffing and scheduling of

their TMCs are assumed to possess a degree of computer experience such that the act of double-clicking on an application to open it is consistent with previous experiences, and is therefore not a problem for most experienced computer users.

The human factors expert suggests that the command prompt window that appears during initialization is a minor usability issue (severity rating of 2) for two reasons:

1) The command prompt is a distraction that provides very little informative feedback to the user, thus competing for the visual attention resources of the user in an uncooperative manner
2) The command prompt is a potential source of confusion since some experienced GUI interface users will not be familiar with what the command prompt is or why it appears. Since the window does not visibly indicate any alteration of system status after the application is opened (i.e., it does not seem to do anything), some users may be tempted to close the window – not realizing that by doing so they also close the application. Subsequently, having to restart the application increases the user's frustration with the software (especially if any unsaved data was lost as a result of inadvertently closing the application).

Recommendation:
- Remove or automatically hide the command prompt window to increase system effectiveness and user satisfaction by preventing potential unintended closing errors, eliminating visual clutter, and reducing unnecessary confusion. Give this recommendation a low priority when considering changes and revisions.

2.4.1.2   Designating work hours for a particular shift

The task of inputting the work hours for a particular shift was considered to be marginally satisfactory by the domain expert (the user provided a rating of 3 to indicate that the system was usable, but an alternative implementation or explanation would be considerably better). Since the numbers for each column in the "Shift work hours" input area are otherwise arbitrary, the user preferred to have these columns represented as 24 hour clock times.

The human factors expert evaluation also noted the ambiguity of the column labels as a usability issue, and it is addressed in detail in section 2.4.2.

An issue regarding the order of the shifts was also noted (severity rating of 3, indicating that this issue is considered important to fix, and should be given higher priority). Currently, any "part time" shift that is defined after a "full time" shift has already been defined may yield an output that is somewhat questionable. For example, in Figure 1, the input was intended to create part time shifts that covered the heaviest demand periods.
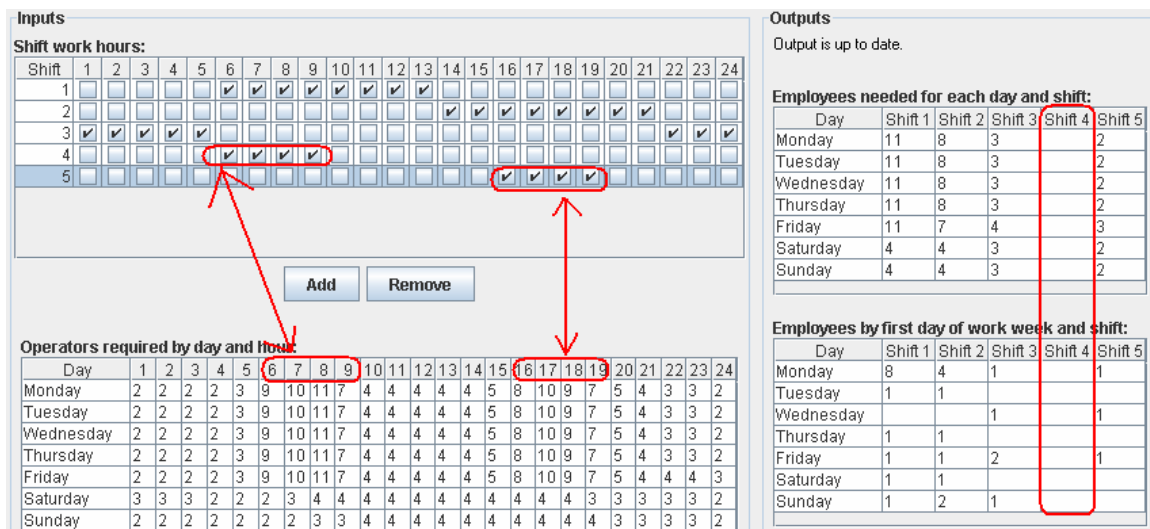
Figure 1: Unexpected results for input.

Shift work hours (Inputs):

Shift	Checked hours
1	6, 7, 8, 9, 10, 11, 12, 13
2	14, 15, 16, 17, 18, 19, 20, 21
3	1, 2, 3, 4, 22, 23, 24
4	6, 7, 8, 9 (circled)
5	16, 17, 18, 19 (circled)

Operators required by day and hour:

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Monday	2	2	2	2	3	9	10	11	7	4	4	4	4	4	5	8	10	9	7	5	4	3	3	2
Tuesday	2	2	2	2	3	9	10	11	7	4	4	4	4	4	5	8	10	9	7	5	4	3	3	2
Wednesday	2	2	2	2	3	9	10	11	7	4	4	4	4	4	5	8	10	9	7	5	4	3	3	2
Thursday	2	2	2	2	3	9	10	11	7	4	4	4	4	4	5	8	10	9	7	5	4	3	3	2
Friday	2	2	2	2	3	9	10	11	7	4	4	4	4	4	5	8	10	9	7	5	4	4	4	3
Saturday	3	3	3	2	2	2	3	4	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	2
Sunday	2	2	2	2	2	2	2	3	3	4	4	4	4	4	4	4	4	4	3	3	3	3	3	2

Outputs — Output is up to date.

Employees needed for each day and shift:

Day	Shift 1	Shift 2	Shift 3	Shift 4	Shift 5
Monday	11	8	3		2
Tuesday	11	8	3		2
Wednesday	11	8	3		2
Thursday	11	8	3		2
Friday	11	7	4		3
Saturday	4	4	3		2
Sunday	4	4	3		2

Employees by first day of work week and shift:

Day	Shift 1	Shift 2	Shift 3	Shift 4	Shift 5
Monday	8	4	1		1
Tuesday	1	1			
Wednesday			1		1
Thursday	1	1			
Friday	1	1	2		1
Saturday	1	1			
Sunday	1	2	1		

The resulting output provides unintended coverage suggestions. However, when the input shift work hours are rearranged so that the part time shifts are defined so that they start first, the output is more intuitive (i.e., start the part time shift at 6 am and the full time shift at 7 am – or start them both at 6 am and have the part time shift defined in any row above the full time shift).
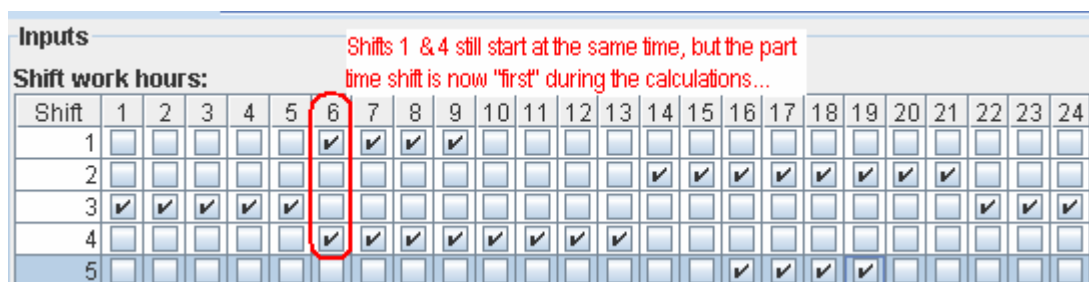

Shifts 1 & 4 still start at the same time, but the part time shift is now "first" during the calculations...

Shift work hours (Inputs):

Shift	Checked hours
1	6, 7, 8, 9
2	14, 15, 16, 17, 18, 19, 20, 21
3	1, 2, 3, 4, 5, 22, 23, 24
4	6, 7, 8, 9, 10, 11, 12, 13
5	16, 17, 18, 19

Figure 2: Order dependencies in shift definition.

This, however, can make it somewhat difficult to define shifts that split the coverage if the part time shift is intended to work "in the middle" of a full time shift – for example, shift 5 in the above example cannot be "fixed" by moving it higher up in the row ordering.

Similarly, empty shifts that are not removed become problematic (severity rating of 3, indicating that this issue is considered important to fix, and should be given higher priority). However, this only seems to occur when the empty shift is in the last (bottom) row of the input area. For example, the image shown in Figure 3 shows an "empty" input configuration for shift 4 that still assigns operators to shift 4 in the output:

Figure 3: Personnel assigned to an undefined shift.

Recommendations:
- Allow the user the freedom to select how the hours are displayed in the column headers (e.g. allow users to select between options or to define their own settings). Add this capability only if time permits.
- Allow the user the freedom to customize the names of the shifts displayed in the row headers (e.g. allow users to select between options or to define their own settings). Add this capability only if time permits.
- Make the output non-dependent on either shift start times or row ordering. Give this issue a high priority when considering changes and revisions to the software.
- Fix the problem that results if an empty shift is in the last row. Give this issue a high priority when considering changes and revisions to the software.

2.4.1.3   Entering the demand

A minor usability issue was noted by the human factors expert (severity rating of 2) regarding the potential difficulty resulting from unintended errors that may occur while entering the number of operators to cover the expected demand, specifically when the user clicks in a cell in the demand table in which a value is already present, types a new value, and expects the system to behave similarly to other spreadsheet applications by "overwriting" the previous value. In the current version of the tool, this expected system behavior does not occur – instead, the new number is appended to the existing number in the cell. For example, if the user was changing a demand value from "3" to "2" and he clicked in the cell and simply typed the number 2 (rather than explicitly deleting the number 3 first), the result is a value of "32" in the cell, rather than the intended change of "3" to "2". This difficulty was corroborated by the user, who noted it in the difficulty log.

Additionally, the efficiency of the system is hampered by the repetitiveness required when entering the demand – it is especially noticeable when users are entering similar demand across either hours (columns) or days (rows).

A severity rating of 1 by the human factors expert indicates both of these issues need not be fixed unless extra time allows.

Recommendations:

- When editing a cell, make the cell behave similar to user expectations by "overwriting" existing text when the cell is single-clicked, and append to the existing text only when a double click in the cell occurs.
- Allow a copy and paste option to improve efficiency when entering similar demand across either hours (columns) or days (rows).
- Allow selectable options for column labels (or allow user to define their own meaningful labels for the numbers and rows - e.g., 24 hour clock times).

The recommendations above are considered "enhancements" and should be performed only if extra time allows.

2.4.1.4 Adding and removing shifts

Adding new shifts is easy and intuitive, and no usability issues were documented. However, the effectiveness of removing shifts poses a minor usability issue (severity rating of 2), because errors may arise due to the unintended deletion of a shift.

Another minor usability issue involves the placement of the Add/Remove buttons. The buttons should be grouped with better proximity to the items they control. Currently, the buttons are visually separated from the shifts, located outside the border for this input control area.

Additionally, the efficiency of the tool is hampered when deleting more than one shift, as the user currently must perform the same sequence of tasks for each row.

Recommendations:
- Confirm actions that may not be desired - e.g., "Are you sure you want to delete shift 5? Yes/No". This issue needs to be addressed, but give this a low priority when considering changes and revisions.
- Move the Add and Remove buttons to be within the border area of the input items they control (see Figure 5 below for a visual representation). This issue needs to be addressed, but give this recommendation a low priority when considering changes and revisions.
- System efficiency may be improved by allowing multiple selections of rows for deletion (i.e., select more than one row at a time for simultaneous removal). This recommendation is considered an enhancement, and need not be implemented unless extra time is available.

2.4.1.5 Saving and loading input data file

Neither saving input data nor loading data files present any noteworthy usability issues from the domain user, who was satisfied with the functionality.

The human factors expert discovered the potential for unintentional errors that could result in the loss of operator demand input and shift configuration data (severity rating of 3). For example, a user may intend to save changes to these inputs before overwriting them with a new file – but may have his work interrupted at the moment he is thinking of saving the changes. When he resumes work on the staffing and scheduling, he may think

he has already saved the data (or he may forget that he meant to save it in the first place) and loads a new data file that overwrites any changes he made to the previous data. The overwritten data cannot be retrieved.

Recommendations:
- Prompt to save the current schedule before exiting the program or loading a new schedule that overwrites the current schedule. This issue needs to be addressed, but give this a low priority when considering changes and revisions.

2.4.2   Layout and presentation of input area elements

The domain expert user provided the following ratings and comments regarding the user interface layout and presentation:

Table 2: Data input layout and presentation user ratings and comments.

Evaluation Item	Satisfaction Rating	Comments
Layout and presentation		
Order of layout for input data requested (i.e., progression of defining work hours before defining operator demand)	4	
Clarity and meaningfulness of labels for input area (e.g., "Shift work hours" and "Operators required by day and hour")	4	
Clarity and meaningfulness of column and row names for each input area	3	See above comment. Identifying times (not numbers) would make this a lot easier to read and interpret.
Clarity and meaningfulness of button labels (e.g., "Add", "Remove", "Save", "Load")	4	
Relevance and usefulness of tool tip hints	3	Could pop up faster. Did not notice them on my first use.
Overall appeal of layout and visual presentation	4	

In Evaluation II, the human factors expert noted potential errors in interpreting column and row headings that may result from the layout of the input elements (severity rating of 3). Figure 4 depicts how the headings labeled "Shift" and "Day" are ambiguous as to whether they are meant to define the first row or the first column, thus burdening the user to carefully inspect the interface in order to make the determination.

Inputs

Shift work hours:

Shift	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1						✔	✔	✔	✔	✔	✔	✔	✔											
2														✔	✔	✔	✔	✔	✔	✔	✔			
3	✔	✔	✔	✔	✔																	✔	✔	✔

Only after inspection of the entire input interface input area is a user able to determine whether these lables are for the first row or the first column...

[Add]   [Remove]

Operators required by day and hour:

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Monday	2	2	2	2	3	9	10	11	7	4	4	4	4	4	5	8	10	9	7	5	4	3	3	2
Tuesday	2	2	2	2	3	9	10	11	7	4	4	4	4	5	8	10	9	7	5	4	3	3	2	

Figure 4: Unclear column labels.

The labels for each shift default to an indexed integer. Making the shift label textbox editable will give the user the freedom to create their own meaningful names for their shifts (e.g., "Day", "Swing", and "Night" rather than "1", "2", and "3").

Additionally, to improve ease of use, the label for the title of the "Operators required by day and hour" can specifically state that the intent of the input area is to input the *number* of operators needed.

Recommendations:
- Explicitly and distinctly label the row and column headers by distinguishing each group separately and then labeling the groups. Figure 5 is offered as a visual reference for the recommendation (note that the "Number of operators needed…" demand input area is modified to make it consistent with recommended changes to the tool's output display that are discussed later).

  The proposed changes exceed the scope of the simple tool being developed in the current effort. The proposed design changes will be noted in the Tool Enhancement Document to be developed in Task D.
- Make the textbox fields of the shift labels editable to allow the user to create their own meaningful names for each of their shifts. Give this recommendation low priority when considering changes and revisions to the software interface.
- Change the title of the lower input to specify that the number of operators required is what is being entered. Give this recommendation low priority when considering changes and revisions to the software interface.
- If possible, decrease the lag time associated with the tool tip text for each interface element. The domain user was unaware that any tool tips existed until he was shown. Fix this issue if time permits.

Figure 5: Conceptual rendering of input areas.

2.4.3   Interpreting and understanding the output generated by the tool

The domain expert user provided the following ratings and comments related to the output data displays of the tool:

Table 3: Output data displays user ratings and comments.

Evaluation Item	Satisfaction Rating	Comments
Overall Ease of Use		
Generating the output data	4	
Understanding and interpreting the data output for "Employees needed for each day and shift"	4	
Understanding and interpreting the data output for "Employees by first day of work week and shift"	3	This table could be defined better by changing the title of the table (i.e. Number of employees starting by day of week). Currently the table's title is overcomplicated.
Understanding and interpreting the data output for "Excess hours per week"	2	For the user, this is interesting and important. However, there is no point of reference for where the excess hours are coming from in order to improve efficiency. This tool should be used to not only organize a schedule, but to optimize the resources and required costs associated with staffing. By simply identifying the excess hours, it is not assisting in allowing the user to make alterations to the schedule to better optimize it. The tool does not have to fix the excess hours identified, but should allow the user to identify where in the week and shifts these excess hours are being incurred.
Understanding and interpreting the data output for "Scheduling Efficiency"	2	A good reference number with little importance should the user not choose to flip through the instructions to identify what it is trying to tell you. Some kind of roll-over definition and "goal range" should be made available.
Exporting the output schedule data to a .csv file	4	
Viewing the .csv file	3	A note should be made in the instructions or the table itself that informs the user that in order to view the file in Excel, you must select "view all file types" from the Excel file menu. CSV files do not present themselves in Excel without doing so.
Layout and presentation		
Clarity and meaningfulness of labels for output area	3	See responses above.

Clarity and meaningfulness of column and row names for each output area	4	
Clarity and meaningfulness of button labels	3	CSV is not a standard extension. I would define it instead of using an acronym (i.e., the button labeled "export CSV" is not clear as to what will execute if selected). Perhaps simply stating "export to Excel" would clarify its purpose.
Relevance and usefulness of tool tip hints	3	Could pop up faster. Did not notice them on my first use.
Overall appeal of layout and visual presentation of output	4	

Please provide any general comments you have regarding your interaction with the tool:

(1) The tool is useful by identifying the number of employees requires by day of week but does not identify where the "soft time" (overlap) time is being incurred. This is stated in my comments in the above table.

(2) Something that could be added to make this even more useful is the option of taking the information provided from the 2 "outputs" to prepare a blank employee schedule (exportable to Excel, allowing for individual employee names to be entered) from the information calculated. This would clarify any confusion from the outputs and make the tool's deliverable even more "final".

2.4.3.1 Generating the output data

Once all the input data is entered, generating output data is easy and intuitive, and no usability issues were documented.

2.4.3.2 Understanding and interpreting the data output

The domain expert was satisfied with the data output presented in the "Employees needed…" table. In the "Employees by first day…" output table, the domain expert noted that the table would be easier to understand if the title of the table were better defined.

The human factors expert discovered that the names of the shifts in the column headings for "Employees needed for each day…" become unreadable when more than 5 shifts are present (severity rating of 2).

The domain expert also noted that the information presented in the output display area for "Excess hours…" was of intense importance to TMC managers who are responsible for staffing and scheduling, and expressed a strong interest in being able to easily identify exactly where "soft time" was being incurred.

The issue noted by the domain user with regards to the "Scheduling efficiency" output display (i.e., that the efficiency should have an identifying roll-over hint) is an artifact of

the time lag associated with the tool tips in the application. This provides further support for the recommendation to reduce the tool tip pop-up delay.

Recommendations:
The problems and issues noted by the domain expert for the output display area are likely to be experienced very often, and will likely persist (especially for infrequent users). Against the relative simplicity of the tool, these issues appear to unnecessarily overcomplicate the process of understanding and interpreting the most important part of the application, magnifying the severity of the any perceived problem.

The rendering in Figure 6 provides a visualization of a proposed design that alleviates confusion associated with title labels, eliminates the problem of the names of the shifts being unreadable when more than 5 shifts are defined, and provides details of where the "soft time" is being incurred.

The redesigned output display will likely be too large to fit within the area of the current output display, and may exceed the viewing area available on some computer monitors if this is attempted. Therefore, it is recommended that the output display be a new window that is generated when the user presses the calculate button. However, to ensure the software tool is compliant with Section 508 of the Rehabilitation Act, considerations of accessibility must be observed. The software application should alert users who rely on screen readers that the output will be displayed in a new window. Section 508 compliance can be maintained by changing the label on the button currently labeled as "Calculate" (in the input area) to "Generate New Output Window", along with a new tool tip associated with the button that advised the user that a new window will open. In addition to eliminating problems with losing on-screen real estate to the output display, having each calculated output data be displayed in a new window will allow the user the option to perform side-by-side comparisons of one or more output display data for variations of demand and shift configurations input.

This issue needs to be addressed; however, the proposed changes exceed the scope of the simple tool being developed in the current effort. The proposed design changes will be noted in the Tool Enhancement Document to be developed in Task D.

2.4.3.3   Exporting and viewing the output data in a .csv file
Exporting the data to a .csv file is simple and intuitive, and no usability issues were recorded. However, the user expressed uncertainty at the button labeled "Export CSV…" because he did not understand the .csv extension.

Recommendation:
- Change the label on the "Export CSV" button to something more clear. If the recommendations regarding reconfiguring the output display are implemented, "Save" would be a valid label. Otherwise, "Export" or "Export to Excel" are possible alternatives. Give this issue a low priority.

Summary of calculated shift / schedule assignments

Number of employees starting each shift today

Total number of employees per shift for today

Shift	Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sunday	
1														
2														
3														
4														
5														

Details of excess work hours each shift

Original number of employees needed

Actual number of employees assigned

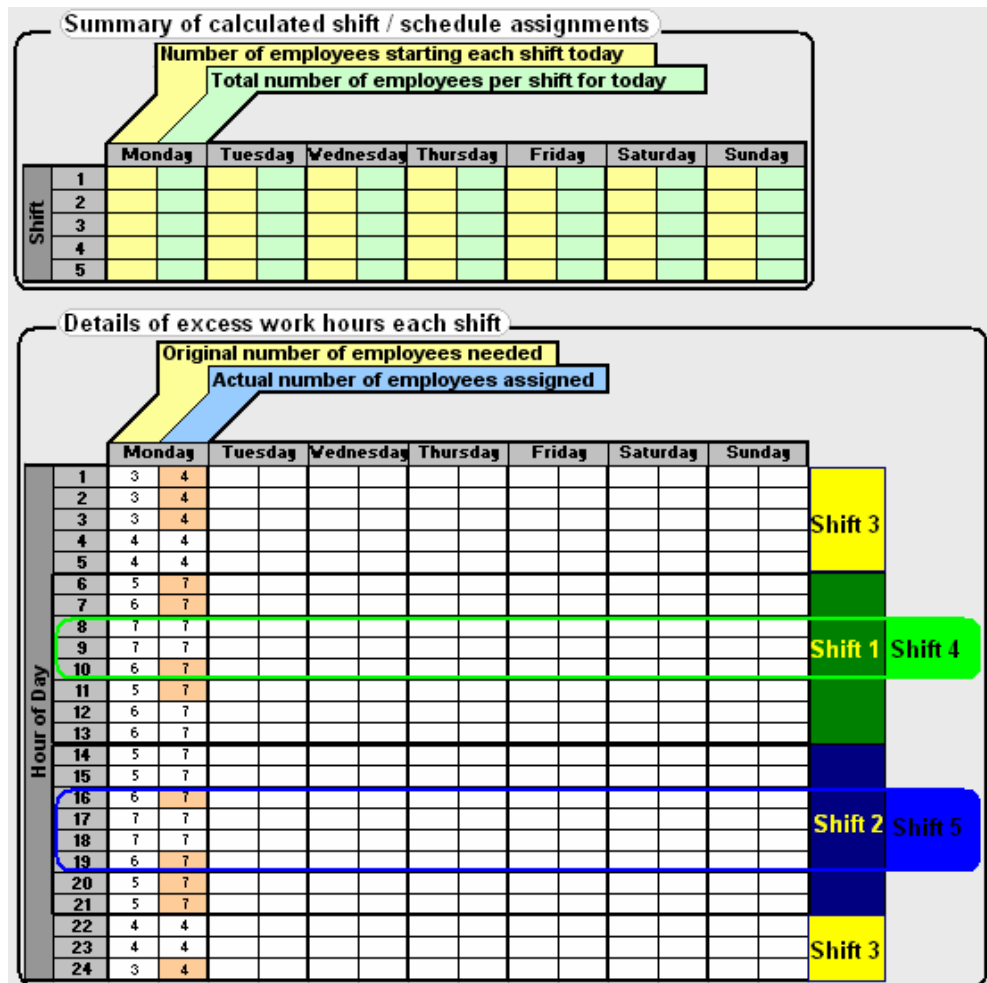| Hour of Day	Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sunday		
1	3	4													Shift 3
2	3	4													
3	3	4													
4	4	4													
5	4	4													
6	5	7													
7	6	7													
8	7	7													Shift 1 / Shift 4
9	7	7													
10	6	7													
11	5	7													
12	6	7													
13	6	7													
14	5	7													
15	5	7													
16	6	7													Shift 2 / Shift 5
17	7	7													
18	7	7													
19	6	7													
20	5	7													
21	5	7													
22	4	4													Shift 3
23	4	4													
24	3	4													

Figure 6: Proposed redesign of output display.

2.4.4   Calculating the relief factor for scheduling

Table 4: Relief factor user ratings and comments.

Evaluation Item	Satisfaction Rating	Comments
Overall Ease of Use		
Inputting the data	1	This field is too ambiguous. I like that there is a definition box located next to the entry field. However the "total days off" field could be simplified and a lot more accurate if a worksheet could be added to define the number of vacation days, sick days, paid holidays, and personal days that can be accumulated by employee (based on the number of employees entered into the second field). The worksheet's total could then be exported to the first field (Total Days Off) and be a lot more accurate and user friendly.
Understanding and interpreting the output	1	Not clear at all. If the second field asks the user for the "number of employees" then it is hard to understand what the last output field ("employees required") is telling you. Seems like a contradiction and not easily deciphered.
Layout and presentation		
Clarity and meaningfulness of labels for input information	1	"Number of Employees" and "Number of Positions"…it is not clear what the difference between these 2 fields are. Are positions referring to "employees" or "work stations"?
Clarity and meaningfulness of the descriptions of the input data requested	2	Don't think the current descriptions will provide much assistance to the user. Needs a lot more detail and examples would help clarify significantly.
Overall appeal of layout and visual presentation of output	1	A lot of what I am addressing above could be rectified by providing definitions for the outputs (yellow boxes). Currently the outputs cannot be selected to provide a description in the field to the right side of the screen.

Please provide any general comments you have regarding your interaction with the tool:

While this part of the tool can ultimately provide some excellent information to the user, its current state does not promote clarity with respects to the information it is trying to gather from the user or of its outputs.

Simplifying by over-defining the inputs and outputs on this page would make it a lot more user friendly.

The comments made by the domain user are echoed by the human factors expert. Even after reading through the help documentation and interacting with the interface in several different ways, the input and outputs on this page are still only vaguely understandable to the uninformed user.

Recommendation:
- Provide more detailed explanations and examples for all the fields on the relief factor tab. If time permits, this issue should be corrected.

2.4.5   **General aspects of the TMC Staffing and Scheduling Tool.**

Table 5: General aspects user ratings and comments

Evaluation Item	Satisfaction Rating	Comments
General		
Access to help materials or user manual for the tool	4	
Completeness of information requested in the input process	2	The relief factor could use additional inputs (by employee, see comments above) to get a more accurate conclusion.
Adequacy of the capabilities (features and functionality) of the tool	2	Recommendations and limitations pointed out in the above comments describe the adequacy of capabilities.
Completeness of information generated in the output	1	Both the Shift Scheduler and Relief Factor could use improved outputs. (see previous comments)
Usefulness of tool in enhancing current processes	2	Lots of potential. Needs additional features (schedule generator and days off calculator by employee) and better field definitions.

Please provide any general comments you have regarding your interaction with the tool:

This will be a great resource once it is improved upon from its current state. With a mass of users from various backgrounds utilizing this tool, it becomes essential to simplify it. The developer might understand what is being asked and the resulting outputs, but for someone unfamiliar with the tool it is still open to various interpretations.

Recommendation:
- The human factors expert only adds the following regarding the help documentation: the help document, currently a separate HTML document, should be integrated into the tool itself.

2.4.6   Summary of recommendations

Table 6 summarizes the issues discovered during the tool evaluation, the recommendations for resolving the issues, and the severity rating associated with the issues. The severity ratings, and associated priorities, are

0 – Not a usability problem	May be used to document positive aspects
1 – Cosmetic problem only	Need not be fixed unless extra time allows
2 – Minor usability issue	Fixing this should be given a low priority
3 – Major usability issue	Important to fix, and should be given higher priority
4 – Critical usability problem	Imperative to fix this before the product is released

Table 6: Summary of recommendations.

	Evaluated Item	Description of Issue	Recommendation	Severity Rating (0 to 4)
Inputting Data into the TMC Staffing and Scheduling Tool				
1	Opening the application	Appearance of command prompt window.	Remove or hide the command prompt.	2 (Low Priority)
2	Designating work hours for a particular shift	Algorithm calculation procedure forces specific arrangements of some shifts and/or work hours.	Make the output non-dependent on either shift start times or row order.	3 (High Priority)
		Erroneous assignments are made if the last row is an "empty" shift.	Fix error in output that assigns operators to an empty shift when the shift is the last row.	3 (High Priority)
		Column header labels are ambiguous and arbitrary.	Allow user defined or selectable options for column labels (e.g., 24 hour clock times).	1 (Fix if Time Permits)
		Shift names default to ordered integers.	Allow shift names to be customizable.	1 (Fix if Time Permits)

	Entering the demand	Errors when editing cell values (user expecting "spreadsheet-like" behavior from system).	Make cells behave like spreadsheets – allow "overwrite" on single click cell selection, and "append to text" upon double click into the selected cell.	1 (Fix if Time Permits)
		Potentially repetitious input.	Allow copy and paste.	1 (Fix if Time Permits)
		Column header labels are ambiguous and arbitrary.	Display column headers as 24 hour clock times or make it a user defined option.	1 (Fix if Time Permits)
3	Adding and removing shifts	Add and Remove buttons are visually outside the border for the items they are meant to control.	Move the buttons to be within the input area border.	2 (Low Priority)
		Removal of multiple rows is inefficient.	Allow multiple shifts to be deleted.	1 (Fix if Time Permits)
		Potential for unintended deletion of data.	Prompt for confirmation of removal of shifts, exiting the program, or loading a new schedule.	2 (Low Priority)
4	Loading and saving input data	Potential to unintentionally overwrite existing input data when loading a file.	Before overwriting a currently displayed schedule, prompt to save input data if anything has changed.	2 (Low Priority)
5	Time needed to complete all the data input that is required	Tedious and repetitious data entry is required to input demand information.	A copy and paste option or hot key option to simplify demand input would improve the	1 (Fix if Time Permits)

		satisfaction with the time required.	
6	Clarity and meaningfulness of labels for input area (e.g., "Shift work hours" and "Operators required by day and hour")	The label for the title of the operator demand input area should be made more clear and easier to understand.	Change title of this input area to read "Number of operators required for each hour of the day".	2 (Low Priority)
7	Clarity and meaningfulness of column and row names for each input area	The headings in row #1, column #1 (labeled "Shift" and "Day") are ambiguous as to whether they are meant to define the first row or the first column.	Explicitly and distinctly label the row and column headers by distinguishing each group separately and then labeling the groups.	3 (High Priority)
8	Relevance and usefulness of tool tip hints	User was unaware that tool tips existed because of lag time before tool tip was shown.	Decrease the lag time associated with the tool tip pop-ups.	1 (Fix if Time Permits)
9	Overall appeal of layout and visual presentation	Potential inconsistent interface if the input demand area is not changed to be consistent with the output display proposed.	The input demand area should be changed if the recommendations for changes to the output display are implemented.	N/A (Proposed changes exceed scope of simple tool)

Understanding and interpreting output data provided by the TMC Staffing and Scheduling Tool

10	Understanding and interpreting the output display elements	Confusion associated with title labels. Names of the shifts become unreadable when more than 5 shifts are defined. Strong user desire to see details of where the "soft time" is being incurred.	A redesign of the output display area that appears in a new application window that is Section 508 compliant.	N/A (Proposed changes exceed scope of simple tool)
		Confusion with the "Export CSV…" label on the button.	Change the label on the button to "Save".	2 (Low Priority)

Other recommendations				
11	Calculating the relief factor for scheduling	Inputs and outputs related to relief factor are confusing to an unfamiliar user.	Provide more detailed explanations and examples for all the fields on the relief factor tab.	1 (Fix if Time Permits)
12	Integrating the help content into the tool	Help content appears in a separate HTML document currently	The help document should be integrated into the tool itself.	1 (Fix if Time Permits)

Note to Printer: This is the Spine Title

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Final Tool Evaluation Report

FHWA-OP-06-XXX